WHAT IS CLAIMED IS:

1. A method of estimating the location of a rover station (R) with the use of a first base station (B1) and a second base station (B2), the method comprising:

(a) receiving the known locations of the first base station and the second base station;

(b) obtaining a first time offset representative of the time difference between the clocks of the first and second base stations;

(c) receiving measured satellite navigation data as received by the rover, the first base station, and the second base station;

(d) generating a first set of residuals of differential navigation equations associated with a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured satellite navigation data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

(e) generating a second set of residuals of differential navigation equations associated with a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured satellite navigation data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

(f) generating an estimate of the rover's location from the first set of residuals, the second set of residuals, and the time offset between the clocks of the first and second base stations.

2. The method of Claim 1 further comprising the steps of:

(g) receiving the location of a third base station;

(h) obtaining a second time offset representative of the time difference between the clocks of the first and third base stations;

(i) receiving measured satellite navigation data as received by the third base station; and

(j) generating a third set of residuals of differential navigation equations associated with a third baseline (R–B3) between the rover and the third base station, the residuals being related to the satellite navigation data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station

and the third base station; and

wherein step (f) generates the estimate of the rover's location further from the third set of residuals and the time offset between the clocks of the first and third base stations.

3. The method of Claim 1 wherein step (b) comprises the step of generating the first time offset.

4. The method of Claim 2 wherein step (b) comprises the step of generating the first time offset and wherein step (h) comprises the step of generating the second time offset.

5. The method of Claim 4 further comprising the steps of generating a third time offset representative of the time difference between the clocks of the second and third base stations, and comparing the sum of the three time offsets around a loop of the base stations to the value of zero.

6. The method of Claim 1 wherein the first and second sets of residuals are based on pseudo-range data, and wherein said method further comprises the step of generating a first set of carrier-phase-based residuals of differential navigation equations for the first baseline (R–B1) between the rover and the first base station, the first set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station; and

wherein step (f) generates the estimate of the rover's location further from the first set of carrier-phase-based residuals.

7. The method of Claim 6 further comprising the steps of:

obtaining a first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations;

generating a second set of carrier-phase-based residuals of differential navigation equations associated with the second baseline (R–B2) between the rover and the second base station, the second set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the

second base station; and

wherein step (f) generates the estimate of the rover's location further from the second set of carrier-phase-based residuals and the first set of satellite-phase cycle ambiguities.

8. The method of Claim 7 further comprising the steps of:

obtaining a second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations;

generating a third set of carrier-phase-based residuals of differential navigation equations associated with the third baseline (R–B3) between the rover and the third base station, the third set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein step (f) generates the estimate of the rover's location further from the third set of carrier-phase-based residuals and the second set of satellite-phase cycle ambiguities.

9. The method of Claim 6 further comprising the step of generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals and at least one of the sets of residuals based on pseudo-range data; and

wherein step (f) generates the estimate of the rover's location further from the first set of floating ambiguities.

10. The method of Claim 6 further comprising the steps of:

generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals and at least one of the sets of residuals based on pseudo-range data; and

generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein step (f) generates the estimate of the rover's location further from the first set of fixed integer ambiguities.

11. The method of Claim 7 further comprising the step of:

generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

wherein step (f) generates the estimate of the rover's location further from the first set of floating ambiguities.

12. The method of Claim 7 further comprising the steps of:

generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein step (f) generates the estimate of the rover's location further from the first set of fixed integer ambiguities.

13. The method of Claim 8 further comprising the step of:

generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, the third set of carrier-phase-based residuals, the second set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

wherein step (f) generates the estimate of the rover's location further from the first set of floating ambiguities.

14. The method of Claim 8 further comprising the steps of:

generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of

carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, the third set of carrier-phase-based residuals, the second set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein step (f) generates the estimate of the rover's location further from the first set of fixed integer ambiguities.

15. The method according to claim 6 further comprising the steps of:

obtaining a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations, and

generating corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the locations of the first and second base stations, and an estimated location of the rover station; and

modifying said one or more of the residuals with said corrections.

16. The method according to claim 8 further comprising the steps of:

obtaining a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations,

obtaining a second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations, and

generating corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the second set of second ionosphere delay differentials, the locations of the base stations, and an estimated location of the rover station; and

modifying said one or more of the residuals with said corrections.

17. The method of Claim 16 wherein the correction to the residuals associated with satellite "s" in one or both of the second set of residuals and the second set of

carrier-phase-based residuals is related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{2,1}I_k^s$ is the first ionosphere delay differential associated with satellite "s", and $\Delta_{1,0}\widetilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.

18. The method of Claim 16 wherein the correction to the residuals associated with satellite "s" in one or both of the third set of residuals and the third set of carrier-phase-based residuals is related to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s", and $\Delta_{1,0}\widetilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.

19. The method of Claim 16 wherein the ionosphere delay differential from the first set and associated with satellite "s" may be denoted as $\Delta_{1,2}I_k^s$, wherein the ionosphere delay differential from the second set and associated with satellite "s" may be denoted as $\Delta_{1,3}I_k^s$, wherein the locations of the first, second, and third base stations may be represented by the vectors X_1, X_2, and X_3, and wherein the estimated location of the rover may be represented as $\overline{X}_{0,k}$,

wherein the corrections to one or more of the residuals associated with satellite "s" are related to a quantity $\Delta_{1,0}\widetilde{I}_k^s$, where $\Delta_{1,0}\widetilde{I}_k^s = (\alpha\Delta_{1,2}I_k^s + \beta\Delta_{1,3}I_k^s)$,

wherein α and β are constants that satisfy the relationships:

$$\{\overline{X}_{0,k} - X_1\}_n = \alpha\{X_2 - X_1\}_n + \beta\{X_3 - X_1\}_n$$
$$\{\overline{X}_{0,k} - X_1\}_e = \alpha\{X_2 - X_1\}_e + \beta\{X_3 - X_1\}_e$$

where notation $\{ * \}_n$ denotes the component of the bracketed quantity along the north direction, where notation $\{ * \}_e$ denotes the component of the bracketed quantity along the east direction.

20. The method of Claim 19 wherein the correction to the residuals associated with satellite "s" in one or both of the second set of residuals and the second set of carrier-phase-based residuals is related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{2,1}I_k^s$

is the first ionosphere delay differential associated with satellite "s".

21. The method of Claim 19 wherein the correction to the residual associated with satellite "s" in one or both of the third set of residuals and the third set of carrier-phase-based residuals is related to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s".

22. The method according to Claim 16 further comprising the steps of:

modifying one or more of the above residuals to be dependent upon second order effects in the ionosphere delay corrections applied to the baselines associated with the rover, and

generating an estimate of the second order effects, and

wherein step (f) generates the estimate of the rover's location further from the estimated second order effects.

23. The method according to Claim 16 wherein the method generates the first set of first ionosphere delay differentials and the second set of second ionosphere delay differentials from at least the navigation data that it receives from the base stations.

24. The method according to Claim 16 further comprising the steps of:

generating an initial estimate of the first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations;

generating an initial estimate of second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations;

generating an initial estimate of a third set of third ionosphere delay differentials associated with the satellite signals received along the base line formed by the second and third base stations; and

generating final estimates of the ionosphere delay differentials such that the sum of the final estimates of the first, second, and third ionosphere delay differentials for at least one satellite "s" around a loop of the base stations is substantially zero.

25. The method of Claim 7 wherein the step of obtaining the first set of satellite

carrier-phase cycle ambiguities comprises the step of generating the first set of satellite carrier-phase cycle ambiguities from at least the locations of the base stations, and measured satellite navigation data as received by the base stations.

26. The method of Claim 8 wherein the steps of obtaining the first and second sets of satellite carrier-phase cycle ambiguities comprises the step of generating the first set of satellite carrier-phase cycle ambiguities from at least the locations of the first and second base stations and measured satellite navigation data as received by the first and second base stations, and the step of generating the second set of satellite carrier-phase cycle ambiguities from at least the locations of the first and third base stations and measured satellite navigation data as received by the first and third base stations.

27. The method of Claim 26 further comprising the steps of generating a third set of satellite carrier-phase cycle ambiguities associated with the baseline between the second and third base stations, and comparing the sum of the three sets of satellite carrier-phase ambiguities around a loop of the base stations to the value of zero.

28. A method of estimating the location of a rover station (R) with the use of a first base station (B1), a second base station (B2), and a third base station (B3), the method comprising:

(a) receiving the known locations of the first base station, the second base station, and the third base station;

(b) obtaining a first set of satellite-phase cycle ambiguities related to the baseline between the first and second base stations, and a second set of satellite-phase cycle ambiguities related to the baseline between the first and third base stations;

(c) obtaining a first time offset representative of the time difference between the clocks of the first and second base stations, and a second time offset representative of the time difference between the clocks of the first and third base stations;

(d) obtaining measured satellite data as received by the rover, the first base station, the second base station, and the third base station;

(e) generating a first set of residuals of differential navigation equations for a first baseline (R–B1) between the rover and the first base station, the residuals being related to at least the measured satellite data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first

base station;

(f) generating a second set of residuals of differential navigation equations for a second baseline (R–B2) between the rover and the second base station, the residuals being related to at least the measured satellite data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station;

(g) generating a third set of residuals of differential navigation equations for a third baseline (R–B3) between the rover and the third base station, the residuals being related to at least the measured satellite data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station;

(h) generating an estimate of the rover's location from the first set of residuals, the second set of residuals, the third set of residuals, the first time offset, the first set of satellite-phase cycle ambiguities, the second time offset, and second set of satellite-phase cycle ambiguities.

29. The method of Claim 28 wherein steps (c)-(h) are repeated in a one or more subsequent iterations for a corresponding one or more time moments, and wherein step (h) generates, for each subsequent iteration, an estimate of the rover's location from the first set of residuals, the second set of residuals, the third set of residuals, the first time offset, and the second time offset generated for the iteration, and further from at least one estimated rover location generated by a previous iteration, and from at least the first set of satellite-phase cycle ambiguities and the second set of satellite-phase cycle ambiguities.

30. The method of Claim 28 wherein step (b) comprises:

(i) generating a fourth set of residuals of differential navigation equations for a fourth baseline (B1–B2) between the first and second base stations, the residuals being related to at least the measured satellite data received by the first and second base stations, the locations of the satellites, and the locations of the first and second base stations;

(j) generating a fifth set of residuals of differential navigation equations for a fifth baseline (B1–B3) between the first and third base stations, the residuals being related to

at least the measured satellite data received by the first and third base stations, the locations of the satellites, and the locations of the first and third base stations;

(k) generating a sixth set of residuals of differential navigation equations for a sixth baseline (B2–B3) between the second and third base stations, the residuals being related to at least the measured satellite data received by the second and third base stations, the locations of the satellites, and the locations of the second and third base stations; and

(l) generating the first set of satellite-phase cycle ambiguities, the second set of satellite-phase cycle ambiguities, and a third set of satellite-phase cycle ambiguities from at least the fourth, fifth, and sixth sets of residuals, wherein the third set of satellite-phase cycle ambiguities is related to the baseline between the second and third base stations.

31. The method of Claim 30 wherein step (c) comprises the steps of

generating a seventh set of residuals of differential navigation equations associated with the fourth baseline (B1–B2) between the first and second base stations, the seventh set of residuals being related to at least the measured satellite data received by the first and second base stations, the locations of the satellites, the locations of the first and second base stations, and the first set of satellite-phase cycle ambiguities;

generating an eighth set of residuals of differential navigation equations associated with the fifth baseline (B1–B3) between the first and third base stations, the eighth set of residuals being related to at least the measured satellite data received by the first and third base stations, the locations of the satellites, the locations of the first and third base stations, and the second set of satellite-phase cycle ambiguities; and

generating the first and second time offsets from at least the seventh and eighth sets of residuals.

32. The method of Claim 28 wherein step (c) comprises the steps of

(m) generating a fourth set of residuals of differential navigation equations associated with a fourth baseline (B1–B2) between the first and second base stations, the fourth set of residuals being related to at least the measured satellite data received by the first and second base stations, the locations of the satellites, the locations of the first and second base stations, and the first set of satellite-phase cycle ambiguities;

(n) generating a fifth set of residuals of differential navigation equations

associated with a fifth baseline (B1–B3) between the first and third base stations, the fifth set of residuals being related to at least the measured satellite data received by the first and third base stations, the locations of the satellites, the locations of the first and third base stations, and the second set of satellite-phase cycle ambiguities; and

(o) generating the first and second time offset from at least the fourth and fifth sets of residuals.

33. The method of Claim 28 further comprising the steps of:

obtaining a first ionosphere delay differential related to the baseline between the first and second base stations and a second ionosphere delay differential related to the baseline between the first and third base stations;

generating ionosphere delay corrections for the first, second, and third sets of residuals from at least the first ionosphere delay differential, the second ionosphere delay differential, the locations of the base stations, and an estimated location of the rover; and

wherein step (e) further generates the first set of residuals in relation to the ionosphere delay correction for the first set of residuals;

wherein step (f) further generates the second set of residuals in relation to the ionosphere delay correction for the second set of residuals; and

wherein step (g) further generates the third set of residuals in relation to the ionosphere delay correction for the third set of residuals.

34. A method of estimating the location of a rover station (R) with the use of a first base station (B1) and a second base station (B2), the method comprising:

(a) receiving the known locations of the first base station and the second base station;

(b) obtaining the time offset representative of the time difference between the clocks of the first and second base stations, and a set of satellite-phase cycle ambiguities related to the baseline between the first and second base stations;

(c) obtaining measured satellite data as received by the rover, the first base station, and the second base station;

(d) generating a first set of residuals of differential navigation equations for a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured satellite data received by the rover station and the first base station, the

locations of the satellites, and the locations of the rover station and the first base station;

(e) generating a second set of residuals of differential navigation equations for a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured satellite data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

(f) estimating the rover's location from the first set of residuals, the second set of residuals, the time offset between the clocks of the first and second base stations, and the set of satellite-phase cycle ambiguities related to the baseline between the first and second base stations.

35. A computer program product for directing a computer processor to estimate the location of a rover station (R) with the use of a first base station (B1) and a second base station (B2), the locations of the first base station and the second base station, and measured satellite data as received by the rover, the first base station, and the second base station, the computer program product comprising:

a computer-readable medium;

an initial set of instructions embodied on the computer-readable medium which directs the data processor to receive the known positions of the base stations;

a first set of instructions embodied on the computer-readable medium which directs the data processor to obtain a first time offset representative of the time difference between the clocks of the first and second base stations;

a second set of instructions embodied on the computer-readable medium which directs the data processor to generate a first set of residuals of differential navigation equations associated with a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

a third set of instructions embodied on the computer-readable medium which directs the data processor to generate a second set of residuals of differential navigation equations associated with a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the second base station, the locations of the satellites,

and the locations of the rover station and the second base station; and

a fourth set of instructions embodied on the computer-readable medium which directs the data processing system to generate an estimate of the rover's location from the first set of residuals, the second set of residuals, the time offset between the clocks of the first and second base stations.

36. The computer program product of Claim 35 further for directing the computer processor to estimate the location of the rover station with a third base station at a known location and with the measured satellite data of the third base station, the computer program product further comprising:

a fifth set of instructions embodied on the computer-readable medium which directs the data processing system to obtain a second time offset representative of the time difference between the clocks of the first and third base stations;

a sixth set of instructions embodied on the computer-readable medium which directs the data processing system to generate a third set of residuals of differential navigation equations associated with a third baseline (R–B3) between the rover and the third base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the fourth set of instructions comprises additional instructions that direct the data processing system to generate the estimate of the rover's location further from the third set of residuals and the time offset between the clocks of the first and third base stations.

37. The computer program product of Claim 35 further comprising a set of instructions embodied on the computer-readable medium which directs the data processing system to generate a first set of carrier-phase-based residuals of differential navigation equations for the first baseline (R–B1) between the rover and the first base station, the first set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station; and

wherein the fourth set of instructions comprises additional instructions that direct

the data processing system to generate the estimate of the rover's location further from the first set of carrier-phase-based residuals.

38. The computer program product of Claim 37 further comprising:

a seventh set of instructions embodied on the computer-readable medium which directs the data processing system to obtain a first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations;

an eighth set of instructions embodied on the computer-readable medium which directs the data processing system to generate a second set of carrier-phase-based residuals of differential navigation equations for the second baseline (R–B2) between the rover and the second base station, the second set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

wherein the fourth set of instructions comprises additional instructions that direct the data processing system to generate the estimate of the rover's location further from the second set of carrier-phase-based residuals and the first set of satellite-phase cycle ambiguities.

39. The computer program product of Claim 38 further comprising:

a ninth set of instructions embodied on the computer-readable medium which directs the data processing system to obtain a second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations;

a tenth set of instructions embodied on the computer-readable medium which directs the data processing system to generate a third set of carrier-phase-based residuals of differential navigation equations for the third baseline (R–B3) between the rover and the third base station, the third set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the fourth set of instructions comprises additional instructions that direct the data processing system to generate the estimate of the rover's location further from the third set of carrier-phase-based residuals and the second set of satellite-phase cycle

ambiguities.

40. A computer program product for directing a data processor to estimate the location of a rover station (R) with the use of a first base station (B1), a second base station (B2), a third base station (B3), the locations of the base stations, and measured satellite data as received by the rover and the base stations, the computer program product comprising:

a computer-readable medium;

an initial set of instructions embodied on the computer-readable medium which directs the data processor to receive the known positions of the base stations;

a first set of instructions embodied on the computer-readable medium which directs the data processor to obtain a first time offset representative of the time difference between the clocks of the first and second base stations;

a second set of instructions embodied on the computer-readable medium which directs the data processor to obtain a second time offset representative of the time difference between the clocks of the first and third base stations;

a third set of instructions embodied on the computer-readable medium which directs the data processor to obtain a third time offset representative of the time difference between the clocks of the second and third base stations;

a fourth set of instructions embodied on the computer-readable medium which directs the data processor to generate a first set of residuals of differential navigation equations associated with a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

a fifth set of instructions embodied on the computer-readable medium which directs the data processor to generate a second set of residuals of differential navigation equations associated with a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station;

a sixth set of instructions embodied on the computer-readable medium which directs the data processor to generate a third set of residuals of differential navigation

equations associated with a third baseline (R–B3) between the rover and the third base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station;

a seventh set of instructions embodied on the computer-readable medium which directs the data processor to generate an estimate of the rover's location from the first set of residuals, the second set of residuals, the third set of residuals, the time offset between the clocks of the first and second base stations, and, the time offset between the clocks of the second and third base stations.

41. The computer program product of Claim 40 wherein the first set of instructions comprises instructions that direct the data processor to generate the first time offset from the locations of the first and second base stations and the satellite data received by the first and second base stations;

wherein the second set of instructions comprises instructions that direct the data processor to generate the second time offset from the locations of the first and third base stations and the satellite data received by the first and third base stations; and

wherein the third set of instructions comprises instructions that direct the data processor to generate the third time offset from the locations of the second and third base stations and the satellite data received by the second and third base stations.

42. The computer program product of Claim 40 further comprising:

an eighth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations;

a ninth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations;

a tenth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a third set of satellite carrier-phase cycle ambiguities associated with the baseline between the second and third base stations;

an eleventh set of instructions embodied on the computer-readable medium which directs the data processor to generate a first set of carrier-phase-based residuals for

the first baseline (R–B1) between the rover and the first base station, the first set of carrier-phase-based residuals of differential navigation equations being related to at least the measured satellite carrier-phase data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

a twelfth set of instructions embodied on the computer-readable medium which directs the data processor to generate a second set of carrier-phase-based residuals of differential navigation equations for the second baseline (R–B2) between the rover and the second base station, the second set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station;

a thirteenth set of instructions embodied on the computer-readable medium which directs the data processor to generate a third set of carrier-phase-based residuals of differential navigation equations for the third baseline (R–B3) between the rover and the third base station, the third set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the seventh set of instructions comprises additional instructions that direct the data processor to generate the estimate of the rover's location further from the sets of the carrier-phase-based residuals and the first and second sets of satellite-phase cycle ambiguities.

43. The computer program product of Claim 42 wherein the eighth set of instructions comprises instructions that direct the data processor to generate the first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations from the measured satellite data and positions of the first and second base stations;

wherein the ninth set of instructions comprises instructions that direct the data processor to generate the second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations from the measured satellite data and positions of the first and third base stations; and

wherein the tenth set of instructions comprises instructions that direct the data processor to generate the third set of satellite carrier-phase cycle ambiguities associated with the baseline between the second and third base stations from the measured satellite data and positions of the second and third base stations.

44. The computer program product of Claim 42 further comprising:

fourteenth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations,

a fifteenth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations,

a sixteenth set of instructions embodied on the computer-readable medium which directs the data processor to obtain a third set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the second and third base stations,

a seventeenth set of instructions embodied on the computer-readable medium which directs the data processor to generate corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the second set of second ionosphere delay differentials, the locations of the base stations, and an estimated location of the rover station; and

wherein one or more of the sets of the instructions which direct the processor to generate the residuals further comprises instructions to modify their respective residuals with the corrections.

45. The computer program product of Claim 44 wherein the seventeenth set of instruction comprises:

instructions that direct the data processor to generate the corrections to the residuals associated with satellite "s" along the baseline between the first and second base stations in related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{2,1}I_k^s$ is the ionosphere delay differential associated with satellite "s" along the baseline between the

first and second base stations, and $\Delta_{1,0}\tilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station; and

instructions that direct the data processor to generate the corrections to the residuals associated with satellite "s" along the baseline between the first and third base stations in relation to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\tilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s" along the baseline between the first and second base stations, and $\Delta_{1,0}\tilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.

46. An apparatus for estimating the location of a rover station (R) with the use of a first base station (B1) and a second base station (B2), the apparatus comprising:

(a) means for receiving the locations of the first base station and the second base station;

(b) means for obtaining a first time offset representative of the time difference between the clocks of the first and second base stations;

(c) means for receiving measured satellite navigation data as received by the rover, the first base station, and the second base station;

(d) means for generating a first set of residuals of differential navigation equations associated with a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured satellite navigation data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

(e) means for generating a second set of residuals of differential navigation equations associated with a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured satellite navigation data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

(f) means for generating an estimate of the rover's location from the first set of residuals, the second set of residuals, and the time offset between the clocks of the first and second base stations.

47. The apparatus of Claim 46 further comprising:

(g) means for receiving the location of a third base station;

(h) means for obtaining a second time offset representative of the time difference between the clocks of the first and third base stations;

(i) means for receiving measured satellite navigation data as received by the third base station; and

(j) means for generating a third set of residuals of differential navigation equations associated with a third baseline (R–B3) between the rover and the third base station, the residuals being related to the satellite navigation data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the third set of residuals and the time offset between the clocks of the first and third base stations.

48. The apparatus of Claim 46 wherein the means (b) for obtaining the first time offset comprises means for generating the first time offset.

49. The apparatus of Claim 47 wherein the means (b) for obtaining the first time offset comprises means for generating the first time offset and wherein the means (h) for obtaining the second time offset comprises means for generating the second time offset.

50. The apparatus of Claim 49 further comprising means for generating a third time offset representative of the time difference between the clocks of the second and third base stations, and means for comparing the sum of the three time offsets around a loop of the base stations to the value of zero.

51. The apparatus of Claim 46 wherein the first and second sets of residuals are based on pseudo-range data, and wherein the apparatus further comprises means for generating a first set of carrier-phase-based residuals of differential navigation equations for the first baseline (R–B1) between the rover and the first base station, the first set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station; and

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of carrier-phase-based residuals.

52. The apparatus of Claim 51 further comprising:

means for obtaining a first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations;

means for generating a second set of carrier-phase-based residuals of differential navigation equations associated with the second baseline (R–B2) between the rover and the second base station, the second set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the second set of carrier-phase-based residuals and the first set of satellite-phase cycle ambiguities.

53. The apparatus of Claim 52 further comprising:

means for obtaining a second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations;

means for generating a third set of carrier-phase-based residuals of differential navigation equations associated with the third baseline (R–B3) between the rover and the third base station, the third set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the third set of carrier-phase-based residuals and the second set of satellite-phase cycle ambiguities.

54. The apparatus of Claim 51 further comprising means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals and at least one of the sets of residuals based on pseudo-range data; and

wherein the means (f) for generating the estimate of the rover's location generates

the estimate further from the first set of floating ambiguities.

55. The apparatus of Claim 51 further comprising:

means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals and at least one of the sets of residuals based on pseudo-range data; and

means for generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of fixed integer ambiguities.

56. The apparatus of Claim 52 further comprising:

means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of floating ambiguities.

57. The apparatus of Claim 52 further comprising:

means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

means for generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of fixed integer ambiguities.

58. The apparatus of Claim 53 further comprising:

means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the

second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, the third set of carrier-phase-based residuals, the second set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of floating ambiguities.

59. The apparatus of Claim 53 further comprising:

means for generating a first set of floating ambiguities for the baseline between the rover and first base station from the first set of carrier-phase-based residuals, the second set of carrier-phase-based residuals, the first set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, the third set of carrier-phase-based residuals, the second set of satellite carrier-phase cycle ambiguities related to the baseline between the first and second base stations, and at least one of the sets of residuals based on pseudo-range data;

means for generating a first set of fixed-integer floating ambiguities for the baseline between the rover and first base station from the first set of floating ambiguities;

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the first set of fixed integer ambiguities.

60. The apparatus according to claim 51 further comprising:

means for obtaining a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations, and

means for generating corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the locations of the first and second base stations, and an estimated location of the rover station; and

means for modifying said one or more of the residuals with said corrections.

61. The apparatus according to claims 53 further comprising:

means for obtaining a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations,

means for obtaining a second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations, and

means for generating corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the second set of second ionosphere delay differentials, the locations of the base stations, and an estimated location of the rover station; and

means for modifying said one or more of the residuals with said corrections.

62. The apparatus of Claim 61 wherein the correction to the residuals associated with satellite "s" in one or both of the second set of residuals and the second set of carrier-phase-based residuals is related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{2,1}I_k^s$ is the first ionosphere delay differential associated with satellite "s", and $\Delta_{1,0}\widetilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.

63. The apparatus of Claim 61 wherein the correction to the residuals associated with satellite "s" in one or both of the third set of residuals and the third set of carrier-phase-based residuals is related to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s", and $\Delta_{1,0}\widetilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.

64. The apparatus of Claim 61 wherein the ionosphere delay differential from the first set and associated with satellite "s" may be denoted as $\Delta_{1,2}I_k^s$, wherein the ionosphere delay differential from the second set and associated with satellite "s" may be denoted as $\Delta_{1,3}I_k^s$, wherein the locations of the first, second, and third base stations may be represented by the vectors X_1, X_2, and X_3, and wherein the estimated location of the rover may be represented as $\overline{X}_{0,k}$,

wherein the corrections to one or more of the residuals associated with satellite

"s" are related to a quantity $\Delta_{1,0}\widetilde{I}_k^s$, where $\Delta_{1,0}\widetilde{I}_k^s = (\alpha\Delta_{1,2}I_k^s + \beta\Delta_{1,3}I_k^s)$,

wherein α and β are constants that satisfy the relationships:

$$\{\overline{X}_{0,k} - X_1\}_n = \alpha\{X_2 - X_1\}_n + \beta\{X_3 - X_1\}_n$$
$$\{\overline{X}_{0,k} - X_1\}_e = \alpha\{X_2 - X_1\}_e + \beta\{X_3 - X_1\}_e$$

where notation *{ * }ₙ* denotes the component of the bracketed quantity along the north direction, where notation $\{ * \}_e$ denotes the component of the bracketed quantity along the east direction.

65. The apparatus of Claim 64 wherein the correction to the residuals associated with satellite "s" in one or both of the second set of residuals and the second set of carrier-phase-based residuals is related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{2,1}I_k^s$ is the first ionosphere delay differential associated with satellite "s".

66. The apparatus of Claim 64 wherein the correction to the residual associated with satellite "s" in one or both of the third set of residuals and the third set of carrier-phase-based residuals is related to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\widetilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s".

67. The apparatus according to Claim 61 further comprising:

means for modifying one or more of the above residuals to be dependent upon second order effects in the ionosphere delay corrections applied to the baselines associated with the rover, and

means for generating an estimate of the second order effects, and

wherein the means (f) for generating the estimate of the rover's location generates the estimate further from the estimated second order effects.

68. The apparatus according to Claim 61 wherein the apparatus generates the first set of first ionosphere delay differentials and the second set of second ionosphere delay differentials from at least the navigation data that it receives from the base stations.

69. The apparatus according to Claim 61 further comprising:

means for generating an initial estimate of the first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by

the first and second base stations;

means for generating an initial estimate of second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations;

means for generating an initial estimate of a third set of third ionosphere delay differentials associated with the satellite signals received along the base line formed by the second and third base stations; and

means for generating final estimates of the ionosphere delay differentials such that the sum of the final estimates of the first, second, and third ionosphere delay differentials for at least one satellite "s" around a loop of the base stations is substantially zero.

70. The apparatus of Claim 52 wherein the means for obtaining the first set of satellite carrier-phase cycle ambiguities comprises means for generating the first set of satellite carrier-phase cycle ambiguities from at least the locations of the base stations, and measured satellite navigation data as received by the base stations.

71. The apparatus of Claim 53 wherein the means for obtaining the first and second sets of satellite carrier-phase cycle ambiguities comprises means for generating the first set of satellite carrier-phase cycle ambiguities from at least the locations of the first and second base stations and measured satellite navigation data as received by the first and second base stations, and means for generating the second set of satellite carrier-phase cycle ambiguities from at least the locations of the first and third base stations and measured satellite navigation data as received by the first and third base stations.

72. An apparatus for estimating the location of a rover station (R) with the use of a first base station (B1) and a second base station (B2), the apparatus comprising:

a first antenna which receives navigation satellite signals,

a second antenna which receives data signals from the base stations;

a main processor coupled to an instruction memory and a data memory,

a satellite-signal demodulator coupled to the first antenna and the main processor, the satellite-signal demodulator demodulating the satellite signals and providing measure satellite data related to the rover's location to the main processor;

a base-station information demodulator coupled to the second antenna and the

main processor, the base-station information demodulator demodulating the data signals transmitted by the base stations and providing data demodulated therefrom to the main processor, the data including at least the locations of the base stations and the measured satellite data as received by the base stations;

an initial set of instructions embodied in the instruction memory which directs the main processor to receive the known positions of the base stations;

a first set of instructions embodied in the instruction memory which directs the main processor to obtain a first time offset representative of the time difference between the clocks of the first and second base stations;

a second set of instructions embodied in the instruction memory which directs the main processor to generate a first set of residuals of differential navigation equations associated with a first baseline (R–B1) between the rover and the first base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station;

a third set of instructions embodied in the instruction memory which directs the main processor to generate a second set of residuals of differential navigation equations associated with a second baseline (R–B2) between the rover and the second base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

a fourth set of instructions embodied in the instruction memory which directs the main processor to generate an estimate of the rover's location from the first set of residuals, the second set of residuals, and the time offset between the clocks of the first and second base stations.

73. The apparatus of Claim 72 wherein the apparatus further estimates the location of the rover station with the use of a third base station at a known location and with the measured satellite data of the third base station, the apparatus further comprising:

a fifth set of instructions embodied in the instruction memory which directs the main processor to obtain a second time offset representative of the time difference between the clocks of the first and third base stations;

a sixth set of instructions embodied in the instruction memory which directs the main processor to generate a third set of residuals of differential navigation equations associated with a third baseline (R–B3) between the rover and the third base station, the residuals being related to the measured pseudo-range satellite data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the fourth set of instructions comprises additional instructions that direct the main processor to generate the estimate of the rover's location further from the third set of residuals and the time offset between the clocks of the first and third base stations.

74. The apparatus of Claim 72 further comprising a set of instructions embodied in the instruction memory which directs the main processor to generate a first set of carrier-phase-based residuals of differential navigation equations for the first baseline (R–B1) between the rover and the first base station, the first set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the first base station, the locations of the satellites, and the locations of the rover station and the first base station; and

wherein the fourth set of instructions comprises additional instructions that direct the main processor to generate the estimate of the rover's location further from the first set of carrier-phase-based residuals.

75. The apparatus of Claim 74 further comprising:

a seventh set of instructions embodied in the instruction memory which directs the main processor to obtain a first set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and second base stations;

an eighth set of instructions embodied in the instruction memory which directs the main processor to generate a second set of carrier-phase-based residuals of differential navigation equations for the second baseline (R–B2) between the rover and the second base station, the second set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the second base station, the locations of the satellites, and the locations of the rover station and the second base station; and

wherein the fourth set of instructions comprises additional instructions that direct

the main processor to generate the estimate of the rover's location further from the second set of carrier-phase-based residuals and the first set of satellite-phase cycle ambiguities.

76. The computer program product of Claim 75 further comprising:

a ninth set of instructions embodied in the instruction memory which directs the main processor to obtain a second set of satellite carrier-phase cycle ambiguities associated with the baseline between the first and third base stations;

a tenth set of instructions embodied in the instruction memory which directs the main processor to generate a third set of carrier-phase-based residuals of differential navigation equations for the third baseline (R–B3) between the rover and the third base station, the third set of carrier-phase-based residuals being related to at least the measured satellite carrier-phase data received by the rover station and the third base station, the locations of the satellites, and the locations of the rover station and the third base station; and

wherein the fourth set of instructions comprises additional instructions that direct the main processor to generate the estimate of the rover's location further from the third set of carrier-phase-based residuals and the second set of satellite-phase cycle ambiguities.

77. The apparatus of Claim 76 further comprising:

an eleventh set of instructions embodied in the instruction memory which directs the main processor to obtain a first set of first ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and second base stations,

a twelfth set of instructions embodied in the instruction memory which directs the main processor to obtain a second set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the first and third base stations,

a thirteenth set of instructions embodied in the instruction memory which directs the main processor to obtain a third set of second ionosphere delay differentials associated with the satellite signals received along the base line formed by the second and third base stations,

a fourteenth set of instructions embodied in the instruction memory which directs the main processor to generate corrections to one or more of the residuals, the corrections being related to the first set of first ionosphere delay differentials, the second set of second ionosphere delay differentials, the locations of the base stations, and an estimated location of the rover station; and

wherein one or more of the sets of the instructions which direct the main processor to generate the residuals further comprises instructions to modify their respective residuals with the corrections.

78. The computer program product of Claim 77 wherein the fourteenth set of instruction comprises:

instructions that direct the main processor to generate the corrections to the residuals associated with satellite "s" along the baseline between the first and second base stations in related to the quantity ($\Delta_{2,1}I_k^s + \Delta_{1,0}\tilde{I}_k^s$), where $\Delta_{2,1}I_k^s$ is the ionosphere delay differential associated with satellite "s" along the baseline between the first and second base stations, and $\Delta_{1,0}\tilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station; and

instructions that direct the main processor to generate the corrections to the residuals associated with satellite "s" along the baseline between the first and third base stations in relation to the quantity ($\Delta_{3,1}I_k^s + \Delta_{1,0}\tilde{I}_k^s$), where $\Delta_{3,1}I_k^s$ is the second ionosphere delay differential associated with satellite "s" along the baseline between the first and second base stations, and $\Delta_{1,0}\tilde{I}_k^s$ is an estimated ionosphere delay differential associated with satellite "s" along the baseline between the rover and first base station.